Cabin Crews in Emergency and Abnormal Situations

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The Challenge

Emergency and abnormal situations:
- are often time critical, complex, and/or ambiguous
- are high stress, high workload, and a great deal is at stake
- require exceptionally high levels of coordination inside and outside of the airplane

Emergency and abnormal procedures:
- are generally focused on aircraft systems rather than on the situation as a whole
- are practiced seldom (twice a year or less) and used rarely
- are often highly dependent on fragile cognitive processes
- when needed, are crucial and must be performed correctly
Industry Contacts and Consultants

Manufacturers: Boeing, Airbus Industries, BAe Systems, Bombardier

Regulatory and Governmental Agencies: FAA, CAA (UK), JAA, ICAO, Eurocontrol

Unions and Trade Groups: ALPA, APA, SWAPA, ATA, ADF

Accident Investigation Bodies: NTSB, TSB of Canada, ISASI

Airlines: Airborne Express, Air Canada, Alaska, Aloha, American, Atlantic Southeast, Cathay Pacific, Continental, Delta, Fed Ex, Frontier, Hawaiian, Horizon, JetBlue, Southwest, United, UPS, US Airways, TWA (prior to merger)
Emergency and Abnormal Situations Project
Taxonomy of the Domain

15 Different Categories of Issues:

- Broad, Over-arching Issues (3)
- Issues Related to Checklists and Procedures (3)
- Issues Related to Humans (5)
- Issues Related to the Aircraft (2)
- Issues Related to Training (1)
- Selected Emergency Equipment and Evacuation Issues (1)
15 Different Categories of Issues:

- **Broad, Over-arching Issues**
- Issues Related to Checklists and Procedures
- Issues Related to Humans
- Issues Related to the Aircraft
- Issues Related to Training
- Selected Emergency Equipment and Evacuation Issues
**Emergency and Abnormal Situations Project**

**Taxonomy of the Domain**

**Broad, Over-arching Issues**

- Philosophies
- Economic and Regulatory Pressures
- Definitions & Perspectives

**Philosophies and Policies of Dealing with Emergencies and Abnormal Situations – Manufacturers, Company, ATC, etc.**

**Economic and Regulatory Pressures Pertaining to Dealing with and Training for Emergencies**

**Clarification of terminology (e.g., abnormal vs. emergency) and appropriate usage**
Philosophy of Response to Emergencies

Evident in Checklist Design
Swissair 111 - In-flight Fire
Nova Scotia, Canada
September 2, 1998
If smoke/fumes are not eliminated, land at nearest suitable airport.
ValueJet 592 - In-flight Fire, Florida Everglades, May 11, 1996

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**ELECTRICAL SMOKE OR FIRE**

<table>
<thead>
<tr>
<th>OXYGEN MASKS AND SMOKE GOGGLES</th>
<th>ON/100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>RADIO RACK Switch</td>
<td>VENTURI</td>
</tr>
<tr>
<td>CABIN PRESSURE Control</td>
<td>MANUAL</td>
</tr>
<tr>
<td>EMER PWR Switch</td>
<td>ON</td>
</tr>
<tr>
<td>GEN Control and APU Bus Switches</td>
<td>OFF</td>
</tr>
</tbody>
</table>

**NOTE:** Wait a reasonable time to determine whether to follow step A or B below.

### A. If smoke continues:
- AC and DC BUS X-TIE Switches
- L.GEN or APU BUS Switches
- F/O FLT INSTRUMENTS
- EMER PWR Switch
- AC EMERS FEED C/B’s (K10 & L11)

**NOTE:** If smoke disappears, fault is on AC emergency bus. If smoke continues:
- AC EMERS FEED C/B’s (K10 & L11)
- DC EMERS FEED C/B (M36)
  - [930, 960 Series A/C (N37)]

**NOTE:** If smoke disappears, fault is on DC emergency bus. If smoke continues:
- DC EMERS FEED C/B (M36)
  - [930, 960 Series A/C (N37)]
- BATT Switch

**NOTE:** If smoke disappears, fault is on battery bus. If smoke continues:
- BATT Switch
- BATT DIRECT BUS C/B’s(Overhead)

**NOTE:** If smoke continues:
- BATT DIRECT BUS C/B’s(Overhead)
- DC TRANSFER BUS FEED C/B(M36)
  - [930, 960 Series A/C (N37)]
  - [A/C #960 (M36)]

### B. If smoke stops or decreases, at Captain’s discretion:
- AC & DC X-TIE Switches
- LEFT GEN Switch

**NOTE:** If smoke reappears, fault is on left gen bus, left AC bus, left DC bus, or AC X-tie is shorted:
- L GEN Switch
- R GEN Switch
- F/O FLT INSTRUMENTS
- EMGNCY POWER Switch

**NOTE:** If smoke reappears, fault is on right gen bus, right AC bus, right DC bus, ground service AC bus, battery charger, or AC X-tie is shorted:

[END]
In a study of 15 in-flight fires that occurred between January 1967 and September 1998, the TSB of Canada determined that the average amount of time between the detection of an on-board fire and when the aircraft ditched, conducted a forced landing, or crashed was 17 minutes.
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Checklist and Procedures Issues

Development of Checklists and Procedures

Checklist Structure and Design

Checklist Type and Availability


Checklist Structure and Design – Items, memory items, navigation, locating correct checklist, nomenclature, format, etc.

Checklist Type and Availability – Paper, mechanical, electronic (integrated with aircraft and in electronic flight bags), etc.
The crew followed QRH procedures that were incomplete. This caused the aircraft to fall from 100 ft agl on final approach. The nosewheel separated from the aircraft.

The missing information was included in the AOM expanded checklists but was never transferred to the QRH checklists.
If Pack Fault due to low bleed air supply, and if WING ANTI-ICE is not required:

If Pack Fault due to low bleed air supply, a bleed leak does not exist, and if WING ANTI-ICE is not required:

If Pack Fault due to low bleed air supply, and if a bleed leak does not exist, and if WING ANTI-ICE is not required:

<table>
<thead>
<tr>
<th>PROC: AIR PACK FAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>If Pack Fault due to low bleed air supply, a bleed leak does not exist, and if WING ANTI-ICE is not required:</td>
</tr>
<tr>
<td>BLEED VALVE (Affected side)</td>
</tr>
<tr>
<td>AIR X FEED</td>
</tr>
<tr>
<td>PACK (Affected)</td>
</tr>
<tr>
<td>If above FL370:</td>
</tr>
<tr>
<td>ECON FLOW</td>
</tr>
<tr>
<td>END OF PROCEDURE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If pack not supplied:</th>
</tr>
</thead>
<tbody>
<tr>
<td>If in single pack operation:</td>
</tr>
<tr>
<td>REMAINING PACK</td>
</tr>
<tr>
<td>PACK (Affected)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If pack overheat:</th>
</tr>
</thead>
<tbody>
<tr>
<td>If in single pack operation:</td>
</tr>
<tr>
<td>REMAINING PACK</td>
</tr>
<tr>
<td>PACK (Affected)</td>
</tr>
<tr>
<td>PACK MODE SEL (Affected)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>When turb temp below limit:</th>
</tr>
</thead>
<tbody>
<tr>
<td>PACK (Affected)</td>
</tr>
<tr>
<td>PACK (Affected)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If both packs inoperative:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX ALTITUDE</td>
</tr>
<tr>
<td>WHEN ΔP BELOW 1 PSI:</td>
</tr>
<tr>
<td>RAM AIR</td>
</tr>
</tbody>
</table>
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Issues Related to Humans

Crew Coordination & Response

Checklist Use

Human Performance

Personnel Issues

Roles and Behavior of Others

Distribution and prioritization of workload and tasks, distractions, etc.

Errors made when completing checklists, non-compliance, not accessing checklists at all, etc.

Effects of stress, time pressure, and workload on cognitive performance, memory, creative problem solving, etc.

Emotional / affective responses to stress

Influence of crew backgrounds, experience levels, company mergers, etc.

Role of cabin crew, ATC, dispatch, maintenance, ARFF, MedLink, etc. and the degree to which their procedures are consistent / complementary
Without referring to a checklist to reinstate a pack that had automatically tripped off, the flight engineer opened the outflow valve by mistake (instead of closing it) and caused the aircraft to rapidly decompress.

The captain, flight engineer, and a flight attendant, who had been on the flight deck, each lost consciousness during the event.
In a rapidly deteriorating situation under high stress and workload, some checklist steps were missed which resulted in the aircraft being partially pressurized after making an emergency landing.

The crew and two passengers barely escaped the burning aircraft.
Air Canada 797 - DC-9 In-flight Fire, Covington, Kentucky
June 2, 1983

Initial actions taken by cabin crew to assess and deal with fire were inadequate.

Captain was told the smoke was lessening – 5 ½ minute delay in starting emergency decent.

After poor handoff, ATC identified the wrong radar target as the emergency flight.

First officer turned the air conditioning and pressurization packs off.

Toxic fumes and gases built up, a flash fire occurred soon after landing and 23 passengers died.
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Issues Related to the Aircraft

Critical Aircraft Systems

Automation Issues

Systems within flight protection envelopes, automated systems, etc.

Warnings, warning systems, and “warning overload”

What kinds of automation should be used and under what circumstances and when should automation not be used?

Issues in reverting to manual flying, degradation in hand flying skills, etc.
SAS 751 - MD-81 Dual Engine Failure – Gottrora, Sweden – December 27, 1991

On takeoff, ice was ingested into the engines which damaged the fan stages and caused the engines to surge – all power was lost 77 seconds later.

During the event engine power was increased automatically by the Automatic Thrust Restoration (ATR) feature, which increased the intensity of the surging and contributed to the failure of the engines.

Neither the crew nor the company knew that the ATR feature existed on the airplane.
Erroneous information was sent to the captain’s airspeed indicator and center autopilot by the left air data computer because a pitot tube was blocked.

The crew members were tremendously confused by contradictory warnings (overspeed and stall warnings) and conflicting airspeed indications on the three displays.

The center autopilot and autothrottles contributed to their problems. The crew did not attempt to fly the aircraft manually and tried to use automation in a way that did not help them.

The aircraft crashed into the ocean. All onboard perished.
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Issues Related to Training

Training

Relevant training technologies and approaches

Initial vs. recurrent training in dealing with these situations

Skill acquisition and retention of procedures that are unpracticed or seldom practiced

Training for “textbook” vs. “nonstandard” situations

Training for handling single vs. multiple problems

Joint training of flight and cabin crews

The flight crew mistakenly thought they had problems was with their right engine and shut it down.

Cabin crew and passengers could see flames coming from the left engine but this information was not given to the flight crew.

48 passengers died as a result of the crash landing.

Joint emergency training for flight and cabin crews was recommended by the Air Accidents Investigation Branch of the Ministry of Transport (UK).
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Selected Equipment and Evacuation Issues

- Equipment that is problematic to use in an emergency (e.g., smoke goggles that do not fit over eyeglasses)
- Inadequate training in the use of emergency equipment
- Negative transfer (interference) of equipment usage across different aircraft types
- Confusion or problems regarding the initiation of evacuations
While on final approach the forward flight attendant noticed a burning smell and discovered that the handset to call the cockpit was not working.

After landing she pounded on the cockpit door and yelled to get the flight crew’s attention.

The flight crew never heard the flight attendant pounding or yelling.
Develop guidance for procedure development and certification, training, crew coordination, and situation management based on knowledge of the operational environment, human performance limitations, and cognitive vulnerabilities in real-world situations.
Products and Deliverables

Intermediate Products:

Reports, Articles, Papers, Presentations

End Products:

Field Guides for

• Training Entities and Instructors
• Operators
• Manufacturers
• Regulatory Agencies
(Certification, POIs)
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